**CLEANING SURFACE PARTICLE CONTAMINATION WITH ULTRAPURE WATER (UPW) MEGASONIC FLOW ON GENESIS ARRAY COLLECTORS.** J.H. Allton[1], M.J. Calaway[2], J.D. Hittle[2], M.C. Rodriguez[3], E.K. Stansbery[1], and K.M. McNamara[1]. (1) NASA, Johnson Space Center, Houston, TX; (2) Jacobs Sverdrup/ESC, Houston, TX; (3) GeoControl/ESC, Houston, TX. michael.calaway1@jsc.nasa.gov [2].

**Introduction:** The hard landing experienced by the Genesis sample return capsule breached the science canister containing the solar wind collectors. This impact into the damp lakebed contaminated collector surfaces with pulverized collector and spacecraft materials and Utah sediment and brine residue. The gold foil, polished aluminum, and bulk metallic glass remained intact, but the solar wind bulk and regime-specific array collectors were jarred loose from their frames and fractured into > 10,000 specimens [2]. After a year of investigation and cleaning experimentation, the Genesis Science Team determined that array collectors had 4 classes of contaminants: particles, molecular film, submicron inorganic particulate ("aerosol"), and pre-launch surface contamination [1]. We discuss here use of megasonically energized ultrapure water (UPW) for removing particulate debris from array collector fragments.

**Nature of Particles on Collectors:** Particles on array collector fragments recovered from within the protective baffles of the array frames appear to be mostly pulverized collector material; primarily silicon and germanium dust because these collectors fragmented most easily [2]. Fragments recovered from outer parts of the canister and from outside the canister had higher proportions of pulverized spacecraft material. Examples of these materials are ablator materials, carbon fibers and thermal paint. Sediments and brine residues are derived from the Utah lakebed. The impact site was located on U.S. Army's UTTR Dugway Proving Ground in the Great Salt Lake desert. The surface geology of this area contains a large Pleistocene lacustrine system that contains evaporite brines with primary sediments of halite, gypsum, and aragonite rich carbonate mud [3]. Surface sediments also are deposited by weathering and hydraulic processes that transport sediment from the surrounding alluvial fans that contain many quartzite, basalt, and carbonate breccias [4].

**UPW/Megasonic Cleaning:** Ultrapure water generated for all curation labs at JSC runs at a resistivity of >18MΩ, and, thus having ion concentrations in the low ppt. UPW is a reactive cleaning solvent. The JSC Genesis lab uses a Honda Electronics W-357LS-80 Megasonic cleaner operating at 1MHz oscillation at ~ 100 W with an 8 liters/min. flow rate. This megasonic cleaner is integrated with the lab's UPW system. A 'waterfall' effect is created in the Class 10 cleanroom as shown in Fig. 1. The array fragment is typically placed 3 to 5 mm away from the nozzle for achieving full megasonic force for a length of five minutes. After the UPW/megasonic treatment, the fragment is quickly dried with a jet of nitrogen gas pressurized at 40 psi, which may also mechanically loosen and move surface particles.

Figure 1: UPW/Megasonic cleaning set-up for small fragments. Fragment (arrow) is gripped with tweezers only on edge and held in flowing stream for 5 minutes.

**Cleaning results:** "Before" and "after" images of silicon sample 60178 are shown in Figs. 2 & 3. Particle population is significantly reduced. Based on pixel area comparisons of contrast-enhanced images, particle area coverage was reduced from 0.024 fraction to 0.0057 (80% reduction). Canvas X with scientific imaging was the software used. Particle tracing and effective visualizations of particle density are shown in Figs. 4 & 5. Surface composition analyses of fragments cleaned in this manner are being done by others and will allow assessment of cleaning at elemental level [5].

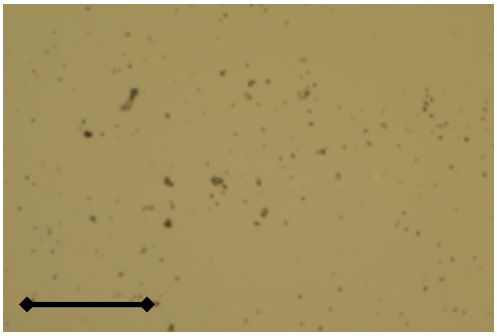

Fig. 2a: Si sample #60178 before UPW cleaning (50 µm scale bar)

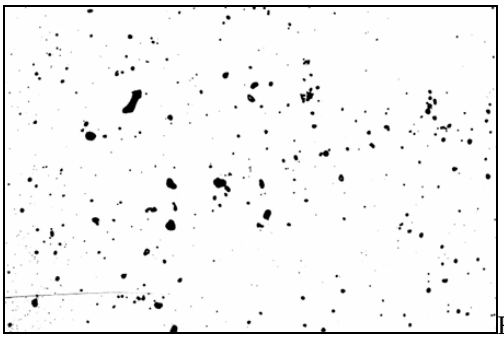

Fig. 2b. Contrast enhanced.

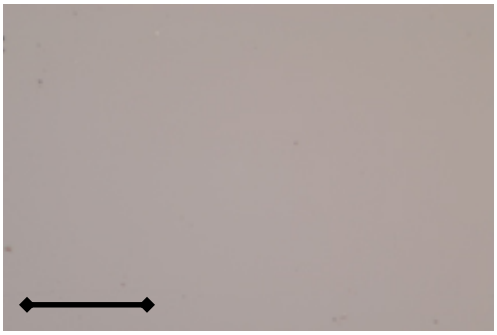

Fig. 3a: Si sample #60178 after UPW cleaning (50 µm scale bar)

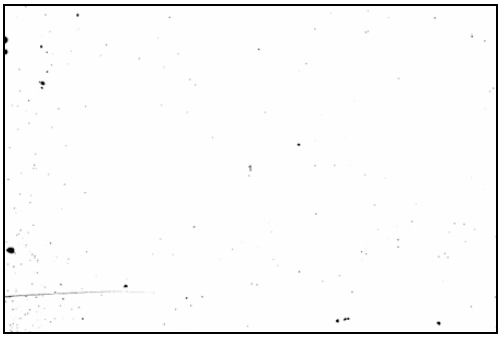

Fig. 3b. Contrast enhanced.

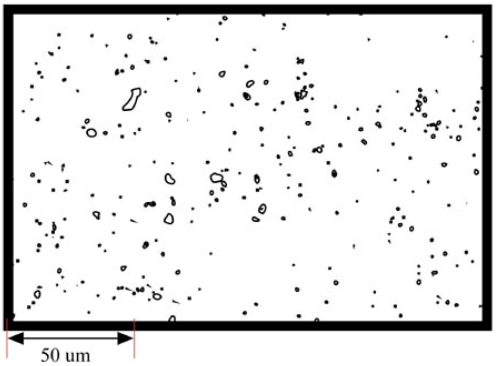


Fig. 4: Si Sample #60178 particle outlines based on Fig. 2a.

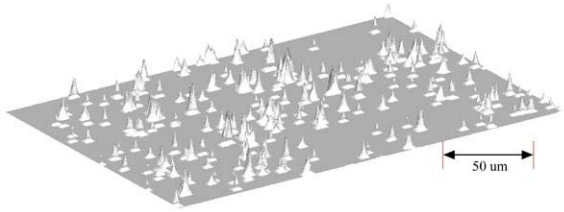


Fig. 5. Si Sample #60178 3D rendering of Fig. 4.

**Surface Particle Mapping:** Andrew Westphal (UC Berkeley) developed particle mapping, wherein a size distribution for particles down to 1 µm particle size can be measured. Since each fragment imaged is registered, the exact area can be re-imaged after cleaning. Depending on resources invested, representative portions or entire fragments could be analytically compared before and after cleaning. Alternatively, simpler methods of calculating area covered by surface particles may be accomplished with off-the-shelf image analysis software.

**Summary:** UPW/Megasonic cleaning appears to be a rapid, simple way to remove larger particles and will be proved very useful if detailed chemical studies support the goal that UPW does not add elemental contamination..

**References:** [1] Burnett D. S. (2006) LPSC XXXVII, [2] Allton J. H. et al. (2005), Abstract #2083, Abstract #1806, [3] J.L. Mason (1997) USGS Pub. 1585; [4] W.B. Langbein (1961) USGS Pub. 412, [5] Brennan S. et al. (2006) LPSC XXXVII.